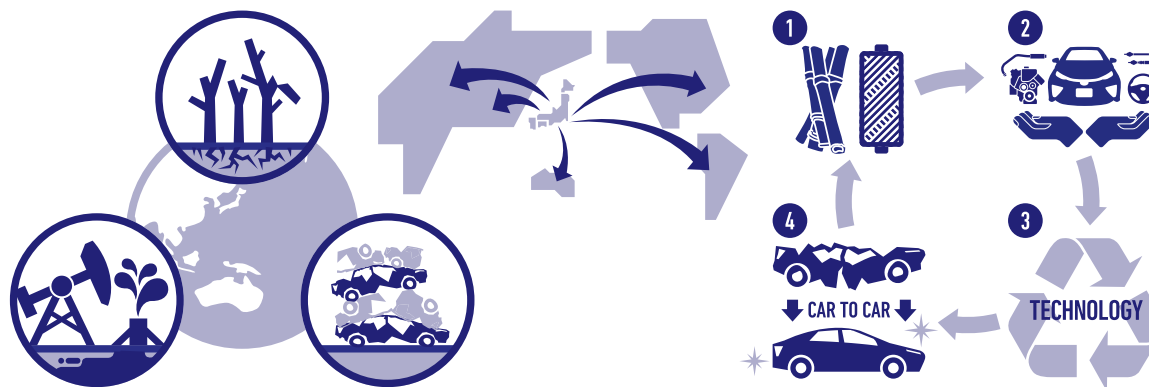


## Challenge 5 Challenge of Establishing a Recycling-based Society and Systems

**Fundamental Approach** Due to global population increase along with the pressure for economic growth and convenient lifestyles, the pace of resource consumption is accelerating. If large-scale exploitation continues as it is, natural resources will be depleted, and if waste increases due to mass consumption, appropriate disposal will be unable to keep pace, resulting in risks of environmental pollution. To prevent the environmental impact caused by End-of-life vehicles, Toyota launched the Toyota Global 100 Dismantlers Project, to establish social systems for End-of-life vehicle proper treatment. In order to realize an ideal resource-recycling based society, it is necessary to grasp the risks of resource depletion and the possibility of creating business opportunities, and initiatives are needed in four key areas: (1) use eco-friendly materials, (2) use auto parts longer, (3) develop recycling technologies, and (4) manufacture vehicles from End-of-life vehicles. Toyota aims to realize the ultimate recycling-based society, and promotes the Toyota Global Car-to-Car Recycle Project (TCCR) so that we can use resources from End-of-life vehicles for manufacturing new vehicles.



### Reduce Consumption of Dwindling Natural Resources Through Use of Renewable Resources and Recycled Materials

#### Reduce the Use of Petroleum-derived Plastics

Since the early 1990s, Toyota has been collecting and recycling bumpers replaced at dealers as a way to reduce the usage of petroleum-derived plastics. Some plastic parts collected from End-of-life vehicles were reused for energy as a heat source except using for used parts. Others were recycled into plastics for non-automobile use after going through a machine-automated sorting process.

In FY2018, we teamed up with dismantling companies to continue implementation of trial tests for collecting End-of-life vehicles-derived plastics, investigated the efficient removal of foreign substances, and undertook measures to create recycled materials that can be utilized in vehicles.

Amid the growing need to further promote plastic recycling, we will continue to study new technologies for collecting and recycling plastics from End-of-life vehicles to support sustainable economic growth globally.

[Environment Data p. 62-I](#)

#### Promote the Reuse of Rare Resources and Recycled Materials

Hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles, fuel cell electric vehicles, and other electrified vehicles use significant amounts of rare resources compared with conventional gasoline vehicles. Some of these resources often carry risks such as resource depletion or uneven supply among regions. In order to promote the reuse of resources and the adoption of recycled materials, we are collaborating with partner companies to establish a framework for collecting and recycling HEV batteries and automobile motor parts, along with cemented carbide tools used in production.

HEV batteries, for example, contain rare metals such as nickel and cobalt. Since launching the first-generation Prius in 1997, we have built our own recovery network to collect End-of-life HEV batteries for recycling and reuse. As of March 2018, we collected 98,700 End-of-life HEV batteries in total.

The collected batteries undergo inspection to determine which parts can be remanufactured into stationary storage batteries or vehicle replacement batteries. Parts not suitable for reuse are recycled as raw metal materials.

Toyota began recycling automobile motor magnets in 2012. As of March 2018, we collected a cumulative 35 tons of magnets, recycling rare earth.

For cemented carbide tools, we launched a system to extract and recycle tungsten<sup>1</sup> in 2010. As of March 2018, we recycled a cumulative total of approximately 170 tons of cemented carbide tools.

The use of Carbon Fiber Reinforced Plastics (CFRP) is expected to increase in the future to support the design of light-weight vehicles. We have made progress toward effective thermal recovery<sup>2</sup> for this material, and development of technologies for material recycling of waste CFRP is ongoing.

As electrified vehicles become further widespread, the amount of End-of-life parts, such as batteries and motors that contain rare resources, is expected to rise. We will continue material recycling activities for End-of-life parts and CFRP.

<sup>1</sup> Tungsten: Japan imports all of its demand for tungsten, which is used in the cutting edges of 80% of cemented carbide tools

<sup>2</sup> Thermal recovery: During the incineration of waste, thermal energy generated is recovered and reused

Cumulative amount of automobile motor magnets recycled

**35 tons**

Cumulative amount of End-of-life batteries collected

**98,700 units**



**Toyota Teams Up with Electric Power Company to Investigate Large-capacity Storage Batteries**

Toyota and Chubu Electric Power Co., Inc. commenced verification project in FY2018 to construct a large-capacity storage battery system that reuses electrified vehicle batteries and recycle End-of-life batteries.

In the verification project, batteries collected from Toyota electrified vehicles that still have storage capacity will be reused in Chubu Electric Power's storage battery system. The objective is to use the batteries in meeting various challenges posed by the electric power system. When combined in large numbers, used batteries, even with reduced performance levels, can be repurposed for energy supply-demand adjustment, frequency fluctuation management, and voltage fluctuation management in distribution systems, all factors that accompany widespread introduction of renewable energy.

Based on the results of the verification tests, the two companies aim to introduce power generation capacity of approximately 10,000 kW, equivalent to 10,000 batteries, in FY2021. The batteries used will be nickel-metal hydride batteries, which are currently being used in large quantities, mainly in HEVs, with plans to also use lithium-ion batteries starting by around 2030.



**Toyota Develops Neodymium-reduced, Heat-resistant Magnet for Use in Motors, Can Reduce Neodymium Use up to 50 Percent**

The magnets used in automobile motors and other components are powerful magnets that contain approximately 30 percent neodymium, a rare-earth element. The powerful neodymium magnets used in automotive and other applications must have high coercivity even at high temperatures. As a result, in addition to neodymium, which is produced in relatively high volumes, rare-metal elements like terbium (Tb) or dysprosium (Dy) are also added. Rare earth elements range from the plentiful and inexpensive to the scarce, but the rare earth elements used to enable magnets to be employed at high temperatures are expensive rare metals with high geopolitical risks. To address this, considerable efforts have been made to develop magnets that do not use these metals and positive results have been achieved. In contrast to this, production volumes of neodymium are relatively high, so there have been few such initiatives, but there are concerns that the supply and demand balance may break down as electrified vehicles become increasingly popular in the future.

The newly-developed magnets do not use scarce rare metals and replace a portion of the neodymium with low-cost and abundant rare earth elements, thereby reducing the amount of neodymium used in the magnet. In addition, new technology that can suppress the deterioration of coercivity and heat resistance was developed so that there is no loss of performance in motors at high temperatures as a result of the replacement of the neodymium. The same heat resistant performance as earlier neodymium magnets is achieved, while reducing the amount of neodymium used by up to 50 percent.

This new type of magnet is expected to be useful in expanding use of motors in various areas such as automobiles and robotics, as well as maintaining a balance between the supply and demand of valuable rare earth resources. Development of elemental technologies for motors, inverters, batteries, and other components will require steady research and development in anticipation of the future. Toyota positions these technologies as essential for electrified vehicles and will continue making steady progress in each and every area, while working to build the foundation that will support the increased use of electrified vehicles in the future.



Motor



Magnet

## Achieve Industry-leading Levels in Easy-to-dismantle Design for Effective Resource Recycling

To promote material recycling of End-of-life vehicles, Toyota directly visits dismantling companies in Japan and overseas to investigate actual conditions and gain insight into the development of vehicle structure that make it easy to dismantle and separate parts. We have actively adopted these designs for new models since 2003 with the launch of the Raum passenger car.

The new Camry, JPN TAXI and Lexus LS unveiled in FY2018 adopt the Toyota New Global Architecture

(TNGA)<sup>1</sup>, a new concept for car manufacturing which ensures superior stability and control along with a comfortable ride with minimal vibration and sway. These vehicles continue to incorporate easy-to-dismantle designs to ensure safe and speedy dismantling operations.

In other areas where we adopt new structures, parts, and other technologies, we will continue to ensure easy-to-dismantle designs in order to maintain and enhance the capability to dismantle vehicles.

<sup>1</sup> TNGA: Toyota's company-wide global initiative to structurally transform automobile design. TNGA aims to dramatically improve the basic performance and marketability of Toyota vehicles by reforming and integrally redeveloping powertrain components and platforms.

### Vehicle Structure for Easy Dismantling

#### Removal of heavy battery components from hybrid electric vehicle

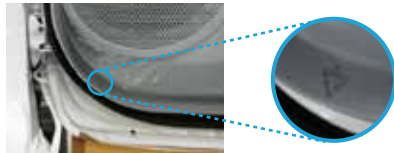
Component removal times for the Prius are further reduced. The new easy-to-dismantle mark has been added to assist in hoisting heavy components with good balance.



#### Removal of door trim<sup>2</sup>

The easy-to-dismantle mark indicates places where the load required for removing the door trim is 30 percent less than usual.

<sup>2</sup> Door trim: The panels lining the inner part of the door

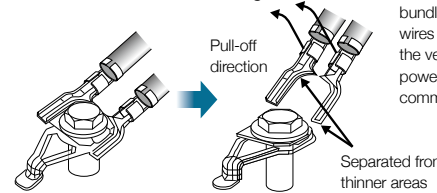


#### Wiring harness<sup>3</sup>

##### Use of pull-tab type ground terminal for wiring harness

Assembled condition

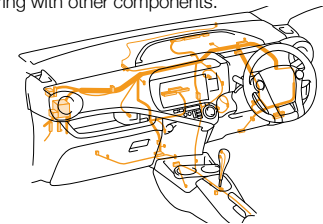
During dismantled



<sup>3</sup> Wiring harness: A bundled assembly of wires running throughout the vehicle body for power supply and signal communications

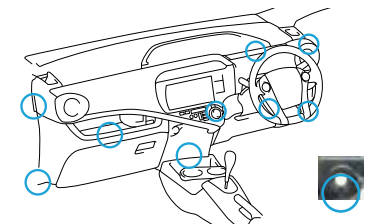
#### Wiring harness layout innovation

The wiring harness can be stripped out without interfering with other components.



#### Removal of instrument panel

The positioning of the V-grooves makes it easy to remove the instrument panel by pulling it strongly.



#### Use of "Easy-to-dismantle mark"

"Easy-to-dismantle marks" are added to show key points for disassembly tasks



## Contribute Worldwide Through Appropriate End-of-life Vehicle Treatment and Recycling Technology Developed in Japan

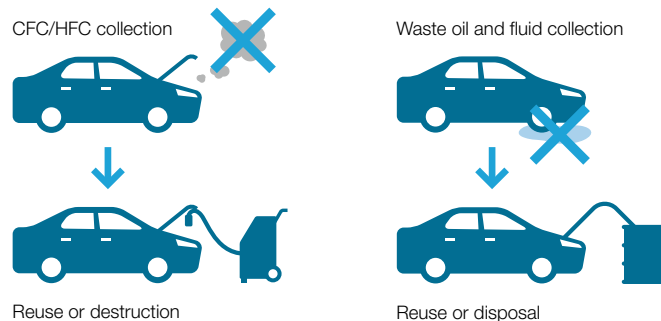
When End-of-life vehicles are not properly disposed or dismantled, this may not only affect regional environments, but also cause risks to the health and safety of local residents. To prevent these problems, we promote the Toyota Global 100 Dismantlers Project. Through this project, we aim to establish social systems for properly treating of End-of-life vehicles without imposing regional environmental impact. Our long-established End-of-life vehicle dismantling technologies and know-how contribute to the establishment of social systems.

In FY2018, we prepared a manual on proper dismantling of End-of-life vehicles and a video manual on airbags deployment for countries and regions that lack suitable dismantling facilities. Responses to the regulation on proper End-of-life vehicle recycling in Vietnam were completed, and a model facility for proper End-of-life vehicle dismantling was established in Thailand.

We have been constantly researching the flow of End-of-life vehicles and setting an each target level according to the conditions of regional infrastructure in cooperation with local affiliates.

We will strive to establish recycling-based societies with proper treatment of waste oil, fluids, CFC/HFC gas and efficient resource recycling by expanding the Toyota Global 100 Dismantlers Project gradually.

### Image of Appropriate End-of-life Vehicle Treatment



### Column Establishment of Vehicle Dismantling Facility as a Model for Southeast Asia (Thailand)

Green Metals (Thailand) Co., Ltd., an affiliate of Toyota Tsusho Corporation, established a model End-of-life vehicle dismantling facility on its site in March 2018. This is the first model facility in Southeast Asia supporting the Toyota Global 100 Dismantlers Project, following a facility established in Beijing, China.

Infrastructure for the proper treatment of End-of-life vehicles has not been established in Thailand, and operations that have negative impacts on the environment such as dumping waste oil and fluids and releasing CFC/HFC gas into the atmosphere are conducted. The establishment of the model End-of-life vehicle dismantling facility is an effort to prevent water and soil contamination through the proper treatment of waste oil and fluids and prevent global warming through collection and destructive processing\* of CFC/HFC gas.

Thailand does not have a legal system regarding End-of-life vehicles such as Japan's End-of-Life Vehicle Recycling Law, and Toyota, TDEM, which is the Asian regional headquarters, and TMT, an affiliate in Thailand, are cooperating with the Pollution Control Department of the Ministry of Natural Resources and Environment, the Department of Industrial Works of the Ministry of Industry, and the Industrial Estate Authority of Thailand to design systems for the proper treatment of End-of-life vehicles. Through these efforts, the entire Group is working together and taking the initiative regarding the proper treatment of End-of-life vehicles.

\* Thermal treatment by Bangpoo Environmental Complex (operated by Waste Management Siam Ltd., an affiliate of Dowaco Eco-System Co., Ltd.)



Model End-of-life vehicle dismantling facility

## Expand Original Recycling Systems for End-of-life Vehicles Worldwide

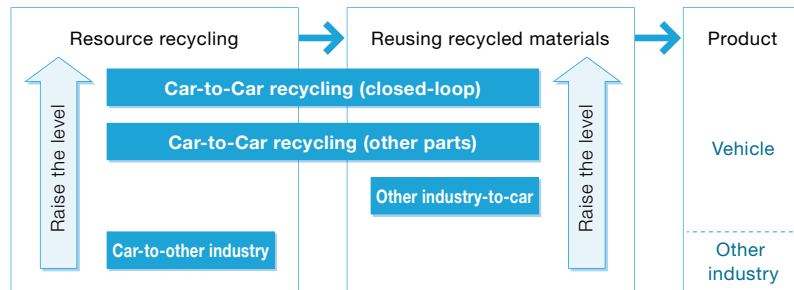
In order to realize an ultimate recycling-based society, we promote the Toyota Car-to-Car Recycle Project (TCCR) that is based on the concepts of reduce, reuse, and recycle, aiming specifically at elimination of resource-related risks and global warming.

In FY2018, we conducted trials with a model in Japan as a blueprint toward the establishment of a global recycling-based society. We are identifying issues for the creation of optimal social systems in 2030.

Batteries for HEVs are expected to increase overseas in the future, and in FY2018, we started initiatives to globalize battery recycling systems, establishing collection and recycling schemes in each region.

The ultimate goal of this project is closed-loop recycling, the concept that the vehicles parts and materials are recycled into identical parts. We will continue promoting “Car-to-Car Recycling” through gradual progress in both aspects of this system, namely the first phase of resource recycling in which vehicle parts and materials are turned into raw materials for new parts, and the second phase of fully reusing recycled materials in new vehicles.

### Image of “Car-to-Car Recycling”



## Reduce Waste and Use Resources Efficiently in Production Activities

Toyota strives to reduce the volume of waste from production activities by developing and deploying new production technologies while taking continual daily measures in terms of the sources of waste (design and production method innovations), resource recycling, resulting cost reductions, and so forth.

In FY2018, Toyota Motor Corporation (TMC) continued waste reduction activities through improvement measures such as sludge volume reduction. The total waste volume, as a result, was 32.7 thousand tons

(down 3.3 percent year on year), and the waste volume per unit produced was 11.3 kg (down 3.1 percent year on year).

Globally, Toyota continuously undertook waste reduction measures and made efforts that lead to cost reductions. Due to changes in the recycling market, however, a shift from selling recycling materials as valuable goods to paying for recycling and so on, the total volume of waste was 499 thousand tons (up 5.3 percent year on year), and the waste volume per unit produced was 47.4 kg (up 5.4 percent year on year).

### Trends in Total Waste Volume and Waste Volume per Unit Produced at TMC (Japan)

Third-Party Assurance

	FY	2014	2015	2016	2017	2018
Total waste volume (thousand tons)		36.0	35.9	35.2	33.8	<b>32.7</b>
Waste volume per unit produced (kg/unit)		12.4	12.5	12.5	11.6	<b>11.3</b>

- Scope of coverage: Production and non-production divisions (excluding employee benefit facilities)
- The total waste volume in production divisions consists of waste generated through production activities
- Waste volume: Waste at cost + incineration + landfill

[Environmental Data p. 62-M](#)

### Trends in Global Total Waste Volumes and Waste Volume per Unit Produced

Third-Party Assurance

	FY	2014	2015	2016	2017	2018
Total waste volume (thousand tons)						
Japan (TMC)		36	36	35	34	<b>33</b>
Japan (consolidated EMS and its subsidiaries)		365	353	348	359	<b>383</b>
North America		32	29	29	30	<b>29</b>
China		20	17	17	17	<b>18</b>
Europe		14	14	11	12	<b>14</b>
Asia (excluding Japan), Australia, Middle East, South Africa, Latin America		27	26	21	22	<b>22</b>
Total		494	475	461	474	<b>499</b>
Waste volume per unit (kg/unit)		47.7	46.0	45.3	45.0	<b>47.4</b>

- Scope of coverage: TMC and consolidated subsidiaries and other companies in Japan and overseas, a total of 121 companies
- Waste volume: Waste at cost + incineration + landfill

[Environmental Data p. 62-N](#)

**Column** **Reducing Waste in C-HR Painting Process (Turkey)**

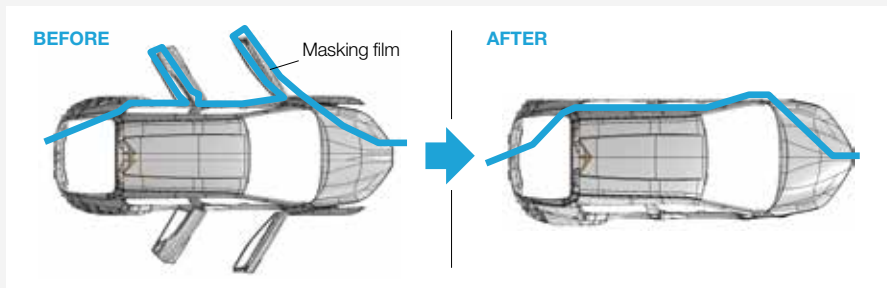
At TMMT, an affiliate in Turkey, the need to perform masking during the painting process arose in conjunction with the introduction of the two-tone C-HR, and the volume of used masking film waste increasing. To address this issue, the company investigated methods of winding the masking film that can maintain paint quality and managed to reduce the volume used through innovations. The amount used per vehicle produced was cut from 1,300 cm to 670 cm, and the labor time was also reduced. The amount of waste generated per vehicle produced was halved from 1,482 g to 723 g, resulting in a 39-ton decrease annually.

TMMT was also able to reduce the number of paint protection plastic caps used when painting bottom surface of vehicle by modifying the movement of painting robot sprayers.

The company also plans to address the reuse of masking film.



Commemorative tree-planting for winning the gold award of the Global ECO. Award by kaizen members



**Column** **Disposal Companies Reviewed and 100 Percent Battery Recycling Achieved (Argentina)**

TASA, an affiliate in Argentina, used to sell approximately 45 tons of End-of-life industrial batteries to several disposal companies as hazardous waste each year. These disposal companies recycled the lead that comprises 65 percent of batteries, and, furthermore, TASA examined the processing methods, processing capacity, and so on of the disposal companies and re-selected the disposal companies that can recycle 100 percent.

**Reduce Packaging and Wrapping Materials and Use Resources Efficiently in Logistics Activities**

Toyota Motor Corporation (TMC) is taking a broad range of initiatives to reduce the amount of packaging and wrapping materials used in logistics. These include increasing packaging efficiency in shipping containers, using returnable containers\* to reduce the amount of unrecyclable materials used, and making packaging and wrapping materials simplified and lighter.

In FY2018, TMC succeeded in reducing the amount of packaging and wrapping material per shipment unit to 6.21 kg/m<sup>3</sup> (down 9.6 percent year on year) by making packaging and wrapping materials smaller and adopting returnable shipping containers. The total volume of packaging and wrapping materials used amounted to 45.8 thousand tons (down 10.9 percent year on year).

Also, on a global basis, Toyota continued efforts to gather and share information on best practices at each affiliate.

Moving forward, we will promote the efficient use of resources when shipping goods, while striving to reduce the volume of packaging and wrapping materials.

\* Returnable: To enable used packaging materials to be returned to original shipping points for reuse

**Trends in Usage of Packaging/Wrapping Materials at TMC (Japan) and Packaging/Wrapping Materials per Shipment Unit at TMC (Japan)**

	FY	2014	2015	2016	2017	2018
Usage of packaging and wrapping materials (thousand tons)		56.3	51.7	50.9	51.4	<b>45.8</b>
Usage of packaging and wrapping materials per shipment unit (kg/m <sup>3</sup> )		6.97	6.98	7.36	6.87	<b>6.21</b>

**Results of Activities to Reduce Usage of Packaging/Wrapping Materials at TMC (FY2018, Japan)**

Products	Main improvement activities	Reduction volume (thousand tons)
Production parts	Use of returnable containers, simplification of packaging specifications	0.4
Service parts	Use of returnable containers and lighter-weight packaging, reuse of packaging and cushioning materials, etc.	0.5
Total		0.9